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G-4

DETAILED FEUERSTEIN TECHNICAL PROJECT REPORT

(as listed on page 64 of
Ticom/E-7)

REFERENCE NO. 1

4599

Agents Transmitter "Taube", Single Sideband Demodulator "Käthe" and Carrier Regenerator "Spitz".

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APPENDIX I

Abstract by SCHEDDIN of Gluhrecht and Epheser's paper published in Physicalisch Berichte, (1941) p. 573.

The authors have set themselves the assignment of bringing the large theory of sifting circuits nearer to an understanding by general workers. The paths traversed by individual theorists in building up the theory are presented coherently and ought to facilitate approach to the work of Cauer by means of a complete and unified presentation of the fundamentals. The properties of electrical filters are determined by the behavior of the apparent resistances of the dipoles of which they are composed. For this reason the general laws of the dipoles are rigorously derived and the realization of such reactances explained on the basis of partial and continued fractions. The quadrapole parameters (Kenngroessen) are derived and canonical quadrapole networks displayed. There follows the derivation of the necessary relation between the branch resistances of a quadrapole for the production of filtering properties. Functions turn up whose appearance give immediately a rough idea of the kind and quality of a filter. The parameters contained in the so-called Q-functions, which parameters can be determined by the methods of Tschebyscheff and Jaumann, represent a more exact adaptation to particular problems in hand. The practical and especially the practicable make up of a filter is the subject of a concluding section. Naturally only hints can here be given, since the practical work requires individual attention to the problems presented. A bibliography at the end of the paper covers the whole modern field of filter theory, the publications of Cauer occupying a large space.

THE AGENT'S TRANSMITTER-TAUBE

1. PURPOSE.

This is a light two-tone MCW transmitter with suppressed carrier (see figure 6). It was designed for automatic high speed transmissions from agents to their headquarters. A special magnetic wire keying unit was designed to go with this unit(but none were built), and at the receiving end was to be a carrier regenerator, a communications receiver with output at its intermediate frequency, a special device to demodulate the two sidebands separately, and a double recorder, The units are all self contained, and many are of interest independent of the agent's radio set proposal, so they willbe treated individually.

2. GENERAL REQUIREMENTS AND DESCRIPTION.

The requirements for this transmitter were that it be a light unit capable of sending short high speed transmissions with good reliability. The equipment furnished consists of two units, the transmitter about 15x16x30 cm and weighing about 5 kg, and the power unit to rest on top of the transmitter, the same size and weighing about 16 kg. The output is about 80 watts, and the equipment can operate continuously. Accurate pretuning was desired, but it was not completly achieved; it was intended to have the receiver pretuned and to devote no time at all on the air to tuning or to establishing contact. About thirty frequencies, all fixed, are claimed to be available. For keying the modulation tone is shifted from the space tone of about 600 cycles to the mark tone of about 800. The frequency range of the transmitter tested was about 3 to 6 mc.

3. GENERAL FUNCTIONING (detailed remarks, next section).

The transmitter contains the following components:
1. Crystal oscillator, 100 kc;

Briefly, the crystal oscillator and the high frequency oscillator are arranged so that the output of the high frequency oscillator is a set of many harmonics of the crystal frequency. These harmonics are sifted in the driver stage so that only the two or so nearest the desired harmonic are present to an objectionable degree(see figures 7 and 8), and these are removed by a special type of circuit in the final stage; this last filter circuit is of an uncommon design.

Modulation is applied using a schemewhich simultaneously suppresses the carrier, leaving only the sidebands. The modulation frequency is from the multivibrator, and this frequency is varied by a key which alters the grid bias on the multivibrator. Thus two-tone MCW keying is achieved, about six hundred cycles for a space, eight hundred for a mark.

4. CIRCUIT OF THE TRANSMITTER.

A block diagram and a set of sketches showing the approximate wave forms in various parts of the circuit are included as figs. 7 and 8. Frequencies of the transmitter are limited to a discreet spectrum by the action of a 100 kc quartz crystal which controls an oscillator. Variation of frequencies over this discrete spectrum is obtained, as outlined above, in several stages. First, the high frequency oscillator is tuned.This is a shock controlled oscillator carefully designed for stability, and each cycle of the 100 kc. oscillator interrupts the high frequency oscillations and allows the non-oscillating tube to reach equilibrium. Thus, oscillations are initiated 100,000 times each second, controlled by the crystal, with the same initial and final phase angle each burst. Thus the output is periodic with a frequency of 100 kc and hence must be made up of sinusoidal components whose frequencies are exact multiples of 100 kc. The amplitudes of the components whose frequencies are near,the basic frequency of the high frequency oscillator are high, and the amplitudes of the components removed in frequency from this value are considerably lower.Therefore, the first tuning step is to bring this oscillator near the desired frequency. The particular component desired is sifted from this spectrum by tuning in later stages described below, but the signal is modulated before this sifting.

Modulation frequencies are generated in a free running multivibrator, whose frequency is controlled by a key which changes the grid basis. It can either be hand keyed or machine keyed by a device to be described later(which device was never finished). The square wave output of the multivibrator alternately blocks two tubes whose control grids both receive the high frequency oscillator output but with a phase difference of 180 degrees. The plates of these two tubes are connected to the same lead in parallel, and this effects a cancellation of the carrier frequency leaving only side bands differing from the carrier by whole multiples of the modulating frequency, with the frequencies next to the central frequency predominant.Thus the discrete spectrum from the high frequency oscillator is further split, with each frequency originally in the spectrum being replaced by a set of frequencies differing from it by an integral multiple of 600 cycles for a space and a multiple of 800 cycles for a mark; of these frequencies, the two next to the old carrier frequency are much the strongest.

This modulated signal with the carrier suppressed is fed to the driver stage, a single tube with a tuned plate circuit. This tuned plate circuit substantially favors the modulated frequency to which it is tuned, and nearly eliminates the more distant frequencies left in the spectrum at that point, leaving the desired frequencies and those 100 and 200 kc away as the only noticeable frequencies. The final stage is a class C amplifier with two tubes in parallel, and it is also tuned. In addition is easiest. If the desired frequency and another frequency 100 kc away both passed this stage in strength, a strong beat note of 100 kc would be produced because of the non linear character of a class C amplifier. The filter opposes this beat note, and through this opposition it opposes the passage of two frequencies 100 kc apart. The desired frequency is already the strongest one by virtue of earlier tuning, and the weaker ones are suppressed.

There is a variable coupling control for the antenna. Two meters are built in to permit tuning with accuracy; one is in the final plate circuit and the other gives the antenna loading.

The power supply is standard.

5. KEYING APPARATUS.

It was planned to construct a magnetic wire recorder on which keying pulses would be recorded. The wire was to be driven through a keying head which would magnetize it longitudinally, say with the north pole leading for a mark and the south pole leading for a space. This magnetic field would be generated from the keying device by means of coils through which direct current flows one way for mark, the other way for space. This magnetization was expected to remove any old magnetization in the wire, and thus to erase and to record simultaneously. To key the transmitter, the wire would again be run through the same head with the coils now leading to an amplifier, and each change in direction of magnetization would result in a voltage pip, which would be amplified and used to key the transmitter.

6, WORKERS

This transmitter was made under the direction of Dr. Griese; most of the work was done by Jakobi.

SINGLE SIDEBAND DEMODULATOR - KAETHE

1. PURPOSE

This is an adapter unit to receive the intermediate frequency signal from an ordinary communications receiver and to demodulate a single sideband, or, using an additional device to demodulate both sidebands independently. As used at the Feuerstein laboratory, Kaethe was a component of the receiving system for the agents' transmitter Taube; this receiving system consisted, first, of the carrier regenerator Spitz (described later), second, a communications receiver, third Kaethe with the additional device for demodulating the two sidebands simultaneously, and finally two audio systems. Figure 9 is a picture of this receiving system with an extra Spitz unit on top of the receiver; Kaethe is shown to the right of the communications receiver and the supplementary unit is shown behind and above Kaethe with its connecting cable lying in front of Kaethe.

2. GENERAL TECHNICAL FUNCTIONING.

Figure 10 is a block diagram of this apparatus.

As operated in the demonstration at the Feuerstein laboratory, a feed from the IF of a Phillips communications receiver at 468 kc is for the upper sideband. Choice of the sideband demodulated is accomplished by means of a switch on the front panel; a third position of the switch bypasses the filters and permits normal operation of the receiver.

From the output of Demod I the circuit splits into a carrier branch and a sideband branch. The sideband is led through a filter whose pass band is about 15.3-18 kc and whose attenuation outside the pass band is about 45 db, and from here it is fed to the final demodulator (Demod III). The carrier branch is fed through another demodulator (Demod II), which, however, normally functions only as a limiter. Demod II can be used as a mixer to change the frequency of the carrier in case it is asymmetric; this frequency is shifted by introducing from an external source a frequency equal to the displacement of the carrier. A carrier filter at 15 kc follows with nominal pass band plus or minus 150 cycles from 15 kc. Two amplifier limiter stages follow, and a rectifier after the last stage furnishes AVC voltage which is fed back to Demod II when it is used as a limiter. A local oscillator (Osc II) within the unit operates at 15 kc, fixed, and its output is compared against the carrier as received from the limiting stages in a phase comparing network. Phase differences produce DC voltages whose polarities depend on which of the two oscillations leads. These voltages control a magnetic variometer in the circuit of Osc I, varying this oscillator's frequency and correcting for tuning errors and drift. Thus Osc I is rigidly controlled so that the beat note between it and the carrier in the IF (which beat note may be further shifted in Demod II) agrees in frequency with Osc II, whose frequency is fixed. The DC control voltage which accomplishes this is also led to a meter to be used as a tuning indicator; this meter is tuned to zero voltage.

Osc II (15 kc.) is used to demodulate the sideband at Demod III. The resulting audio signal is fed into the receiver's audio stages (or another amplifier) and to the output.

3. GENERAL

The unit is in a cabinet measuring about 19x9x9 inches. It was designed by Siemens and Halske, who were just starting to manufacture it at the end of the war. Two models were at Feuerstein, both incomplete and unwired.

4. POINTS OF INTEREST

(1) This unit is a complete departure from standard US and British SSB technique in that all filtering of carrier and sidebands takes place at relatively low frequencies (around 15 kc). US and British practice performs this filtering at approximately 100 kc with consequent elaboration of filter technique (involving crystals, etc.). The lower frequencies used here allow simpler filters. The relative performance of this system vis a vis the standard practice is not known. The general shortage of quartz and quartz grinding facilities in Germany may have influenced the decision to manufacture this equipment.

(2) Provision is made for plugging in an additional filter and demodulator unit for twin sideband operation; in this the two side bands are demodulated separately through two audio channels. If either sideband is selected for the main channel

5. WORKERS

Kaethe was designed at Siemens, where Schindler did some work on it. He also worked on it at Feuerstein, where the incomplete units furnished by Siemens were finished.

CARRIER REGENERATOR SPITZ

1. GENERAL PURPOSE

The original design of this equipment was to furnish a carrier for the suppressed carrier transmissions from Taube. The carrier was to have the frequency of the suppressed carrier, to be pretuned; no phase requirements were set, as single sideband equipment Kaethe was to be used for demodulation and the carrier phase is unimportant with this demodulation. Views of this equipment are in Figure 9.

2. OPERATION

See the block diagram, Figure 11. The radio frequency input without carrier is amplified in the untuned amplifier Amp 1 and led to the receiver along with the output of Amp II. The carrier is generated in Osc II, which is controlled by a 200 KC crystal oscillator, Osc I, in exactly the same way as the high frequency oscillator in Taube; osc is slightly tunable to agree with Taube. Thus Osc II can furnish integral multiples of 200 KC. Amp II serves to remove the undesired frequencies from Osc II, leaving the carrier on the desired frequency. For aligning the receiving equipment, a modulation can be introduced on the carrier from an outside modulating oscillator applied to Amp II. This amplifier also has built in avc.

3. GENERAL APPEARANCE

Spitz is built in a cabinet about 23x23x35 CM. It weighs about 5 KG.

4. RESULTS

It is claimed that the receiving system as set up operated satisfactorily, and that frequency control of Taube and Spitz was accurate enough to achieve the desired results.

DETAILED FEUERSTEIN TECHNICAL PROJECT REPORT

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FIGURES CONTAINED IN REFERENCE 1

This publication contains figures originally published in the General Report on the Feuerstein Laboratory or prepared for other purposes: such figures retain their original numbers. The figures included in this report have the following numbers:-

6, 7, 8, 9, 10 and 11

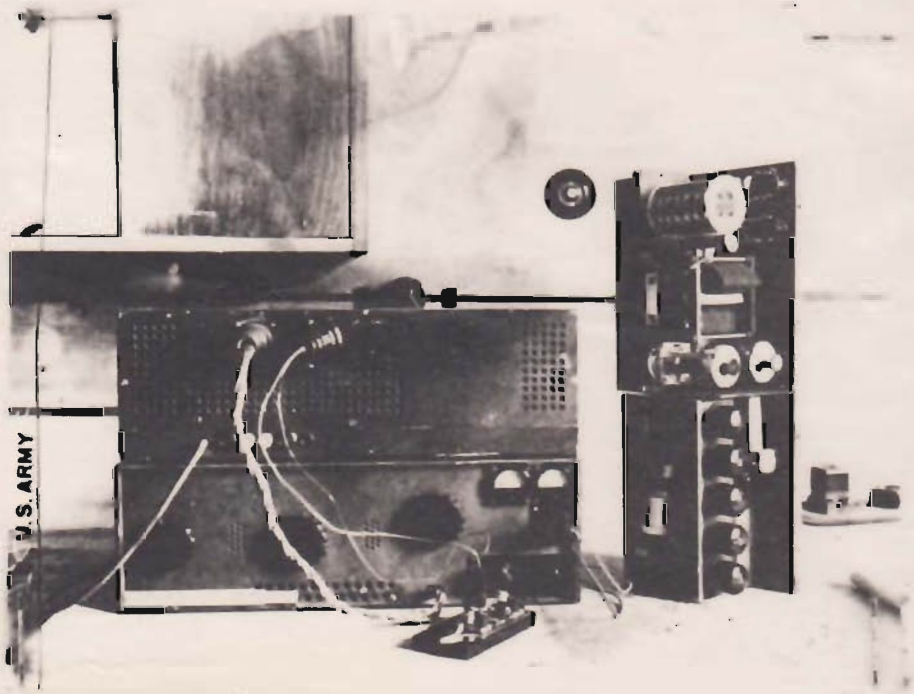


FIGURE 6

Agent's Transmitter Taube ~~- front,~~ (lower unit)
~~Back and Interior Views~~
power supply (upper unit) and interior view
of transmitter (right).

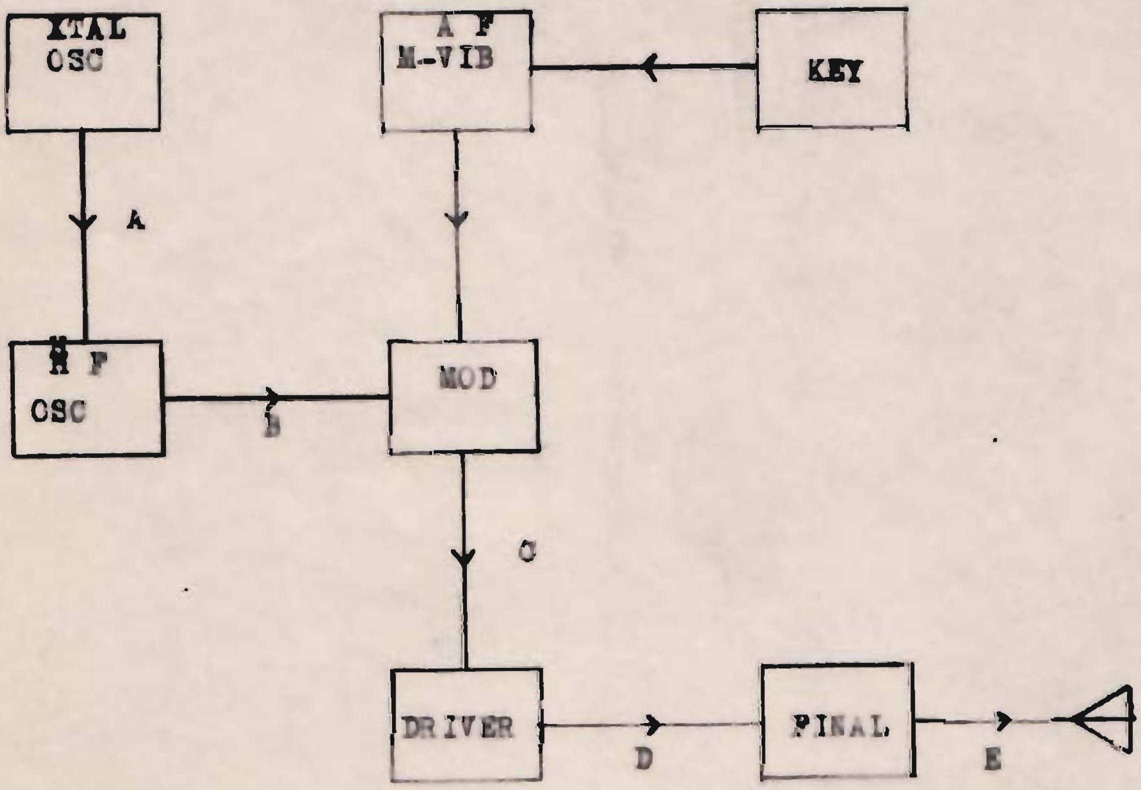


Fig. 7 Block Diagram of Agents' Transmitter Taube

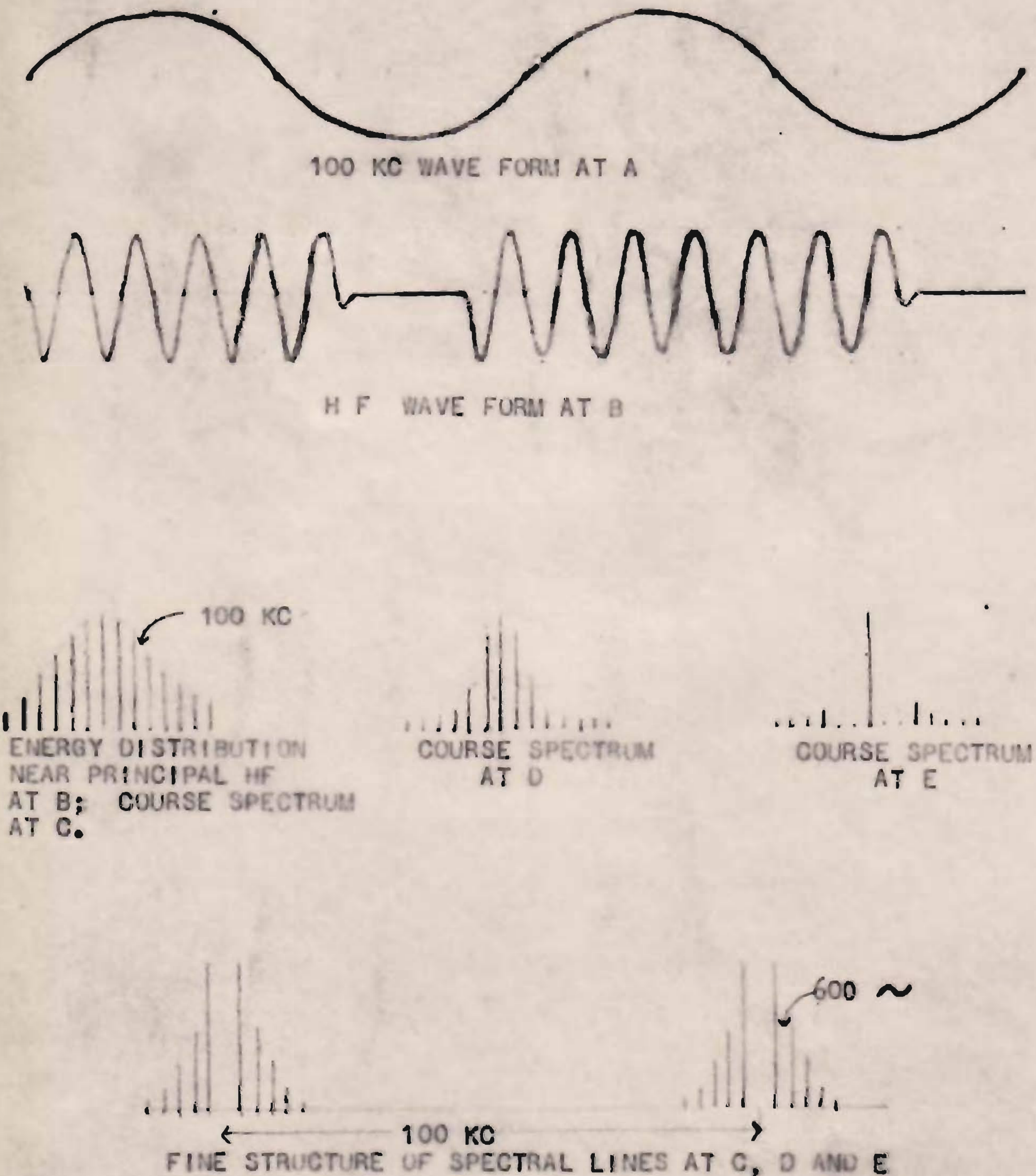


Fig. 8 Diagram of Wave Forms in Agents' Transmitter Taube

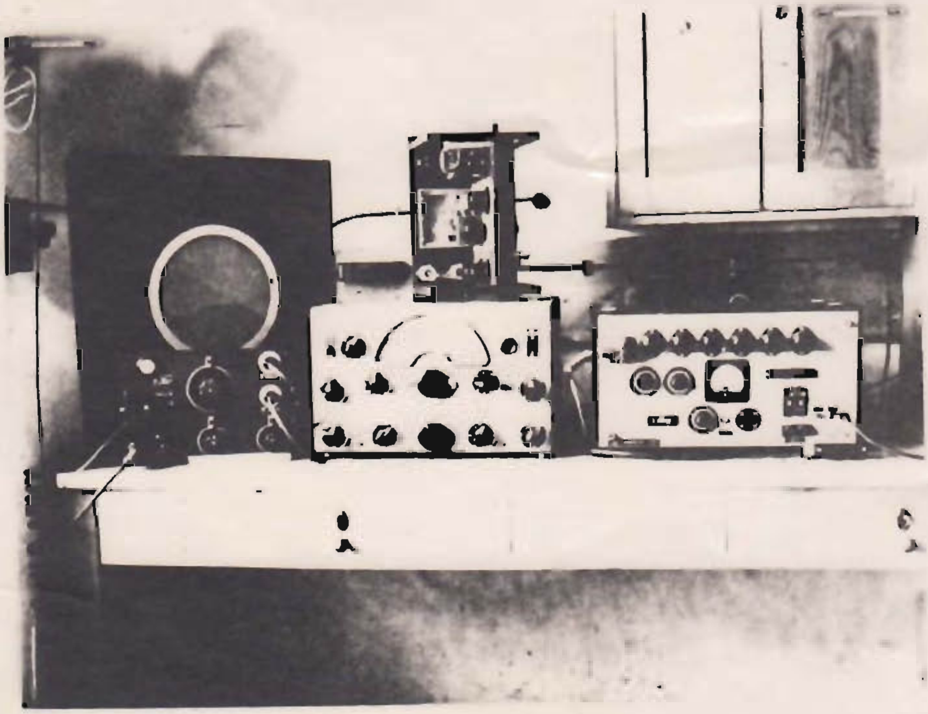


FIGURE 9
SPITZ - Phillips Radio Receiver - Koethe
with open Spitz unit placed over the
receiver

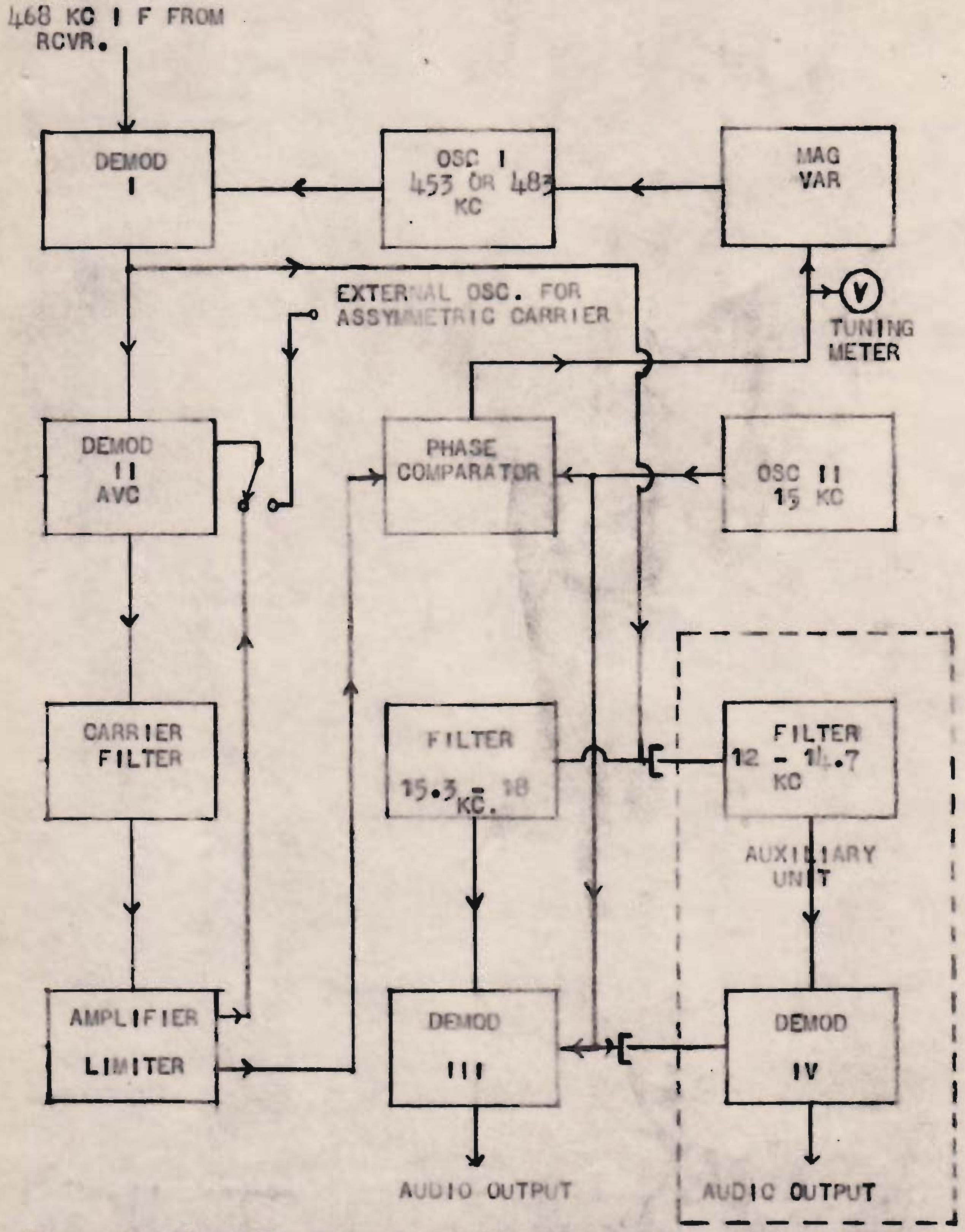


Fig. 10 Block Diagram of Single Sideband Demodulator Kathe

5-8-45 MGG

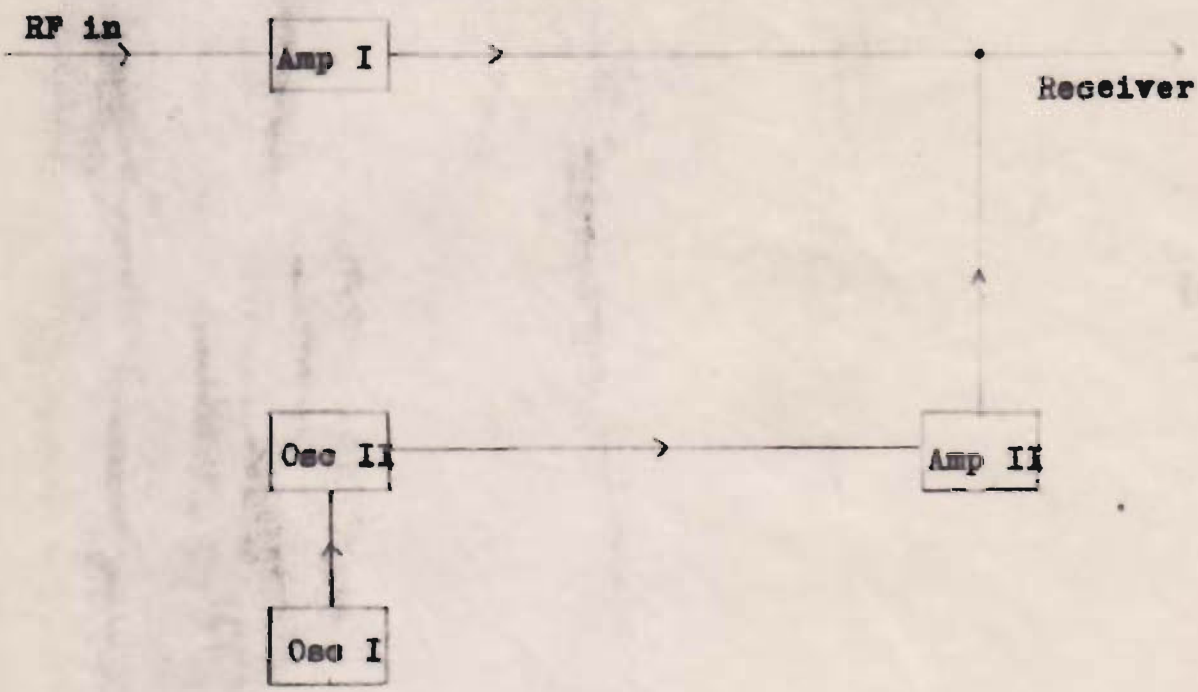
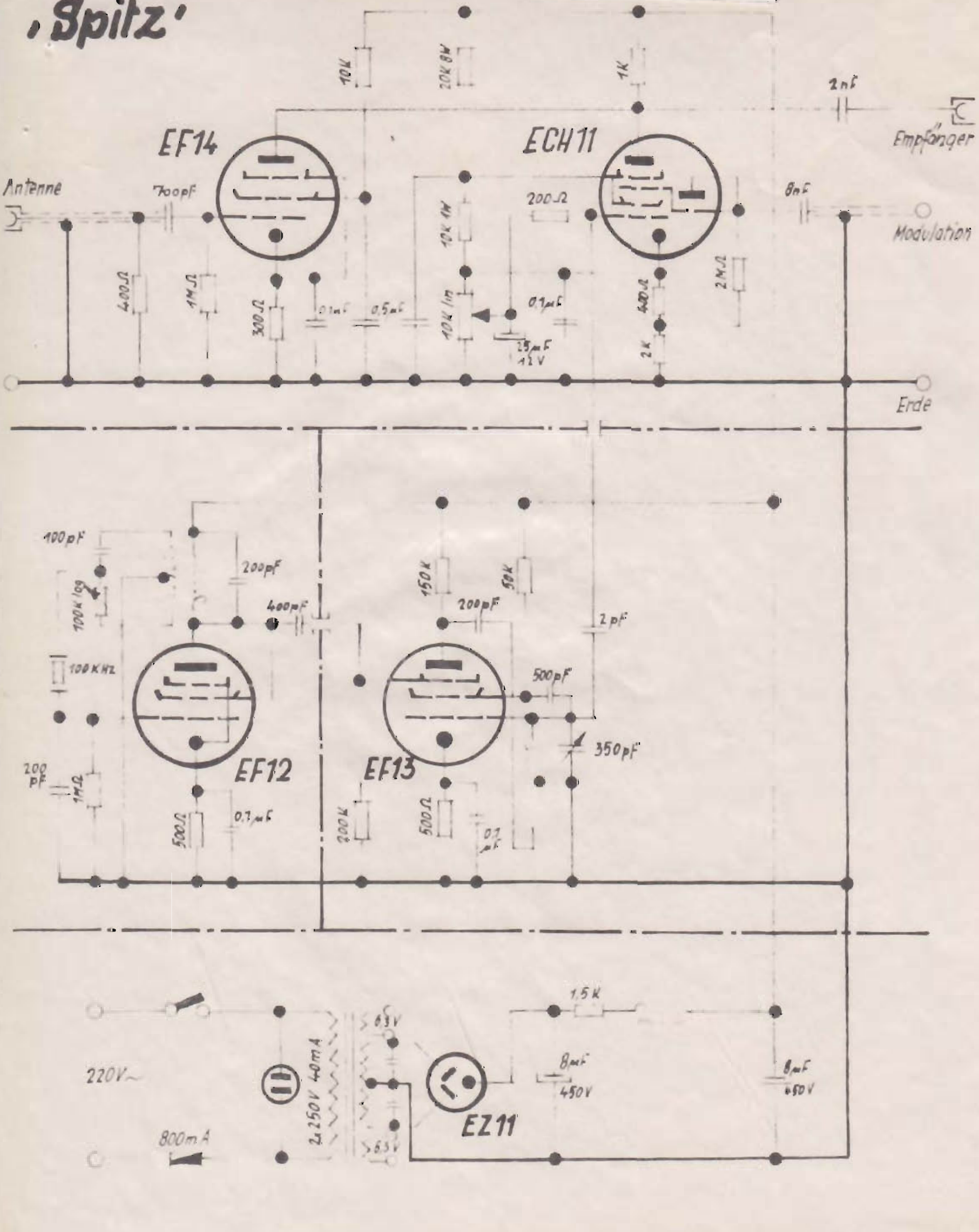


Fig. 11 Block Diagram of Carrier Regenerator Spitz

'Spitz'



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